What is IoT environmental monitoring?

IoT environmental monitoring is a process that uses Internet of Things (IoT) technology to collect data about the environment, such as air quality, temperature, and humidity levels. This data can then be analysed to better understand the indoor and outdoor environment and make informed decisions about how to reduce the impact of negative aspects of the local environment on the business. Alternatively, it can be used to change business activities to help protect the planet or the local community.

These IoT-based systems can be used to detect issues in the environment that are largely invisible, normalised or taken for granted. Allowing businesses to take action by reducing their negative environmental footprint and protecting employees, visitors and the community at large.

IoT is, therefore, becoming increasingly popular across a range of industries for its ability to provide statistics, real-time data and insights that can help businesses understand their environmental impact and how to reduce it, as well as comply with environmental protection standards and policies.

What are the benefits of using IoT-based environmental monitoring?

There are a number of benefits associated with using an IoT-based environmental monitoring system, including:

- **Improved understanding of the environment via data**: With real-time data feeds being supplied by remotely deployed IoT sensors, businesses and organisations can better understand and quantify the environment. From here, targeted actions can be taken to reduce environmental impact or to spot problems, such as excessive CO2, noise or airborne chemicals as they occur.
- **Improved efficiency**: With real-time data, organisations can identify and address any problems long before they become more serious. By employing warning alarms, businesses can be more reactive and proactive. This can result in a better working environment, cost savings and less downtime.
- **Increased sustainability:** IoT environmental monitoring systems help organisations identify areas where they can reduce their areas of environmental stress for employees and stakeholders, thus helping them be more sustainable in the long term.
- **Business Growth**: Companies often need to comply with environmental standards in order to assure their customers that they are a progressive organisation whose values chime and adhere to their own policies and direction of travel. Producing evidence-based systems and results can provide greater surety that measures and controls are in place, fitting both the contexts of the business and its (or its customers) environmental.

What are the four basic steps of environmental monitoring?

There are four critical components for IoT-based environmental monitoring to support vital insights and decision-making:

1) Observation (Monitor the Environment and Collect Data):

The first step in the environmental monitoring process is to observe and collect data. This involves using sensors or other IoT devices to measure factors such as air quality, temperature, and humidity levels.

These connected IoT devices gather data about the environment and transmit it to a central hub. From here, the data can be reviewed in real-time or used for further analysis off line. Often these systems produce unexpected results and temporal variances. For example, high CO2 levels when offices are highly populated could explain drowsiness or loss of concentration. This can also apply to public spaces such as bars and restaurants where invisible environmental factors may be making the consumer experience uncomfortable.

2) Analysis (Measure Data):

The next step is to analyse the data collected by IoT devices. This includes looking at trends over time, identifying areas of concern, and any correlations between environmental variables, time of day, behaviours and the relationships between indoor and outdoor metrics. IoT sensing devices pick out key points of the data that indicate everything from chemical and water leaks to air pollution levels. This data analysis can help businesses measure their environmental footprint and make informed decisions about how to reduce their environmental impact.

For some businesses, this can be relatively benign or related to levels of comfort for workers, whereas others are related to safety. For example, monitoring systems placed in drains can be on the lookout for external pollutants such as diesel, oil, and paints that can stress the environment or harm livestock, fisheries or members of the public.

3) Storage (Catalogue Data):

Once the data has been analysed, it needs to be stored so that it can be accessed in the future. IoT environmental monitoring systems make this easy by storing the data in a secure cloud-based database, allowing businesses to access the data whenever they need it and analyse how their environmental impact is changing over time.

Global databases, such as the Microsoft Planetary Computer, catalogue enormous quantities of environmental data from around the world – although not every cloud database is that large.

4) Action (Provide Actionable Insights From the Data and Analysis):

Finally, businesses need to be able to take action based on the data that has been gathered and analysed.

IoT-enabled environmental monitoring systems can provide insights into how businesses can best reduce their environmental impact, such as by using renewable energy sources or introducing water conservation measures.

These actionable insights may involve changing operational processes, implementing new technologies, or even making changes to their overall business strategy.

What are the devices used for environmental monitoring?

Environmental monitoring devices come in a variety of shapes and sizes, from small handheld devices to larger IoT-enabled systems.

The most common types of environmental monitoring devices include:

- **Sensors**: These measure air quality, temperature, humidity, light levels and other factors. They can also be used to detect chemical or water leaks.
- **Data Loggers**: These record and store data over a set period of time. This can be used to measure changes in the environment over time or detect any sudden changes.
- **GIS (Geographic Information System):** This combines mapping technology with real-time data to provide detailed visualisations of environmental conditions.
- **Remote Monitoring Systems**: These systems allow users to monitor environmental conditions remotely and in real-time, providing timely insights into the state of their environment.
- **Drone-based Systems**: Drones can be used to collect aerial data and conduct surveillance of an environment. This helps businesses monitor for potential problems or hazards, such as oil spills or illegal logging.
- **IoT-Enabled Systems**: IoT-enabled systems collect data from multiple sources and provide a comprehensive view of the environment. These systems are used to measure long-term trends, identify areas of concern, and monitor environmental changes over time.

IoT-enabled environmental monitoring systems are increasingly popular as they provide businesses with the ability to collect and analyse large amounts of data quickly and accurately. This can help inform decisions around reducing their environmental footprint and achieving sustainability goals.

By understanding how their environment is changing, businesses can better prepare for future challenges and ensure that they are acting responsibly and sustainably. With the help of IoT-based environmental monitoring, businesses can make informed decisions about how best to reduce their environmental impact – helping them to operate more efficiently and sustainably in the future.

Uses Cases of IoT Environment Monitoring:

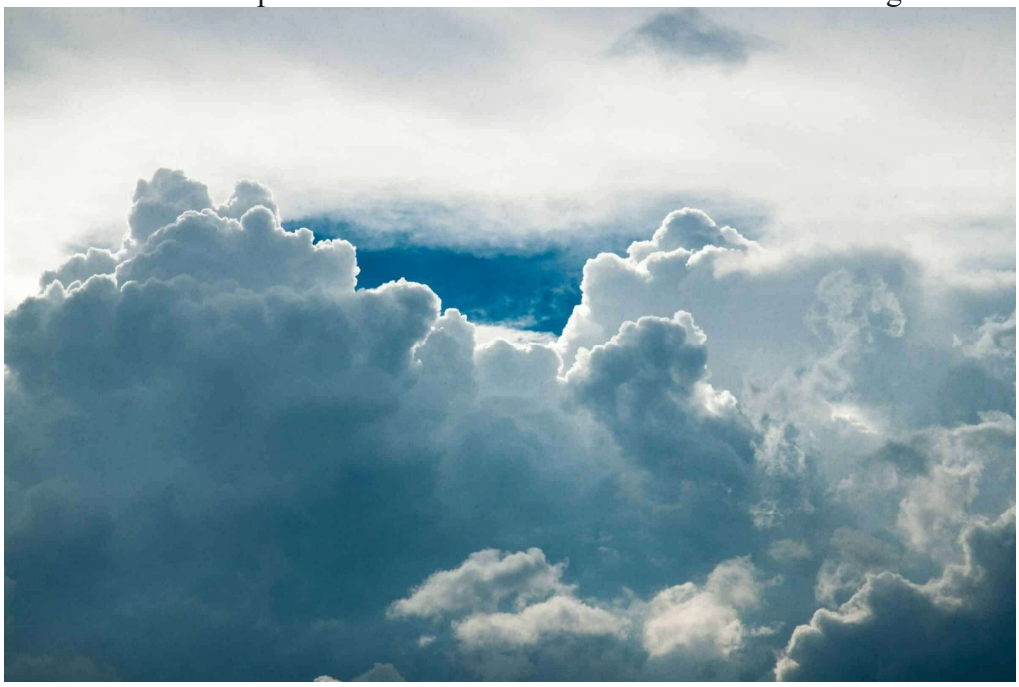
The three main types of environmental monitoring are **soil**, **atmosphere** and **water**. IoT environment monitoring is used in a wide range of industries, from agriculture and forestry to urban planning, energy generation and distribution.

In the agricultural sector, IoT-based systems are used to monitor crops, soil health, water quality and weather conditions. This information can be used to inform decisions about pest control, fertilisation, irrigation and land management.

IoT-based systems in the energy sector are used to monitor emissions, air quality and weather conditions. Thus, helping public bodies, environmental agencies and companies to monitor and take action to reduce negative environmental impact.

Meanwhile, in urban planning, IoT-based systems can be used to monitor traffic congestion or air pollution levels in smart cities. This data can be used to inform decisions about how to reduce the environmental impacts of future urban development.

Below are six examples of use cases of IoT environmental monitoring:



1) Air-quality monitoring:

Industrial processes, like burning fuel, emit air pollutants and organic compounds that can negatively impact human health and the environment.

Whether it's from industrial processes, car exhausts or herds of cattle, the carbon monoxide, hydrocarbons and greenhouse gases emitted must be monitored to ensure good air quality and to protect the wider environment.

Indoor spaces are also subject to pollutants. For example, man-made fibres and materials emit volatile organic compounds (VOCs) over time which are detrimental to human health. Excessive dust and airborne particles are not good for respiratory health and can affect those with COPD and contain allergens for those sensitive to them.

The variance between indoor and outdoor air quality is also important. For example, opening a window to alleviate CO2 levels can cause more problems if outdoor air quality pollution is considered more harmful.

IoT-based systems can be used to monitor air quality in order to detect any changes or anomalies that could indicate an issue. This data can be used to identify areas with poor air

quality, inform decisions around emissions reduction and inform the development of more sustainable processes.
By monitoring emissions in real-time, businesses can take steps to reduce their environmental impact and help ensure compliance with relevant regulations.

2) Water-quality monitoring:

Water quality is an important factor in determining the overall health of aquatic ecosystems and human health for those who inevitably come into contact.
IoT-based water quality monitoring systems can be used to control the contamination levels of water sources and identify any potential pollutants that could be harmful to people or the environment. This data can then be used to help manage water resources more effectively, inform decisions around pollution mitigation and inform the development of sustainable strategies for water management. This data can also be passed on to monitoring authorities for wider consideration and policy formation.

3) Energy monitoring:

Considering there is a limited amount of global energy resources, measures must be taken to ensure effective conservation. IoT-based energy monitoring systems can be used to track energy usage, detect any anomalies or changes that could indicate an issue and inform decisions around energy conservation. This is particularly prevalent within the energy distribution systems and through measurements at points of consumption, most notably through the use of smart meters.

Utilising this data can help prevent spikes in energy usage, stabilise the power grid, and reduce the volume of fossil fuels used in homes and businesses. This data can also be used to measure air quality and identify potential areas for improvement in terms of sustainability.

By recording energy consumption on a real-time basis, businesses can gain valuable insights into their energy usage and make informed decisions around emissions reduction.

4) Commercial farming:

The agricultural sector is one of the most energy-intensive industries, with commercial farming operations requiring huge amounts of energy to power irrigation systems, lighting and cooling.

IoT-based systems can be used to monitor soil health, crop conditions and water quality in order to inform decisions around pest control, fertilisation, irrigation and land management. This data can also be used to inform decisions around energy efficiency and help reduce the environmental impacts of agricultural operations.

Using IoT-based environmental monitoring is an essential aspect of modern sustainable farming, as it enables businesses to monitor and manage environmental conditions on a continuous basis.

Not only can this data be used to inform decisions around emissions reduction and sustainability, but it can help farms reduce their environmental impacts while maintaining profitability.

Other uses for environmental monitoring within commercial farming include tracking the health of livestock, predicting weather patterns and tracking soil temperature.

How to work on wokwi for environmental monitoring project:

Example1:

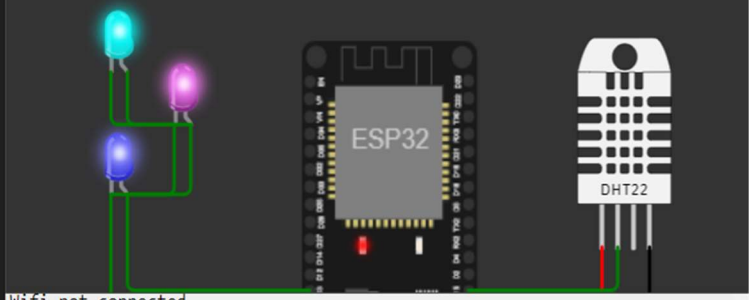
WOKWI SAVE SHARE Docs SIGN IN

sketch.ino | diagram.json | libraries.txt | Library Manager

```
// channel id : 2307358
//channel api key : 1U2N21SZEGP74GFZ


#include <WiFi.h>
#include "DHTesp.h"
#include "ThingSpeak.h"

const int DHT_PIN = 15;
const int LED_PIN = 13;
const char* WIFI_NAME = "Wokwi-GUEST";
const char* WIFI_PASSWORD = "";
const int myChannelNumber =2307358 ;
const char* myApiKey = "1U2N21SZEGP74GFZ";
const char* server = "api.thingspeak.com";

DHTesp dhtSensor;
WiFiClient client;

void setup() {
  Serial.begin(115200);
  dhtSensor.setup(DHT_PIN, DHTesp::DHT22);
  pinMode(LED_PIN, OUTPUT);
  WiFi.begin(WIFI_NAME, WIFI_PASSWORD);
  while (WiFi.status() != WL_CONNECTED){
    delay(1000);
    Serial.println("Wifi not connected");
  }
  Serial.println("Wifi connected !");
```

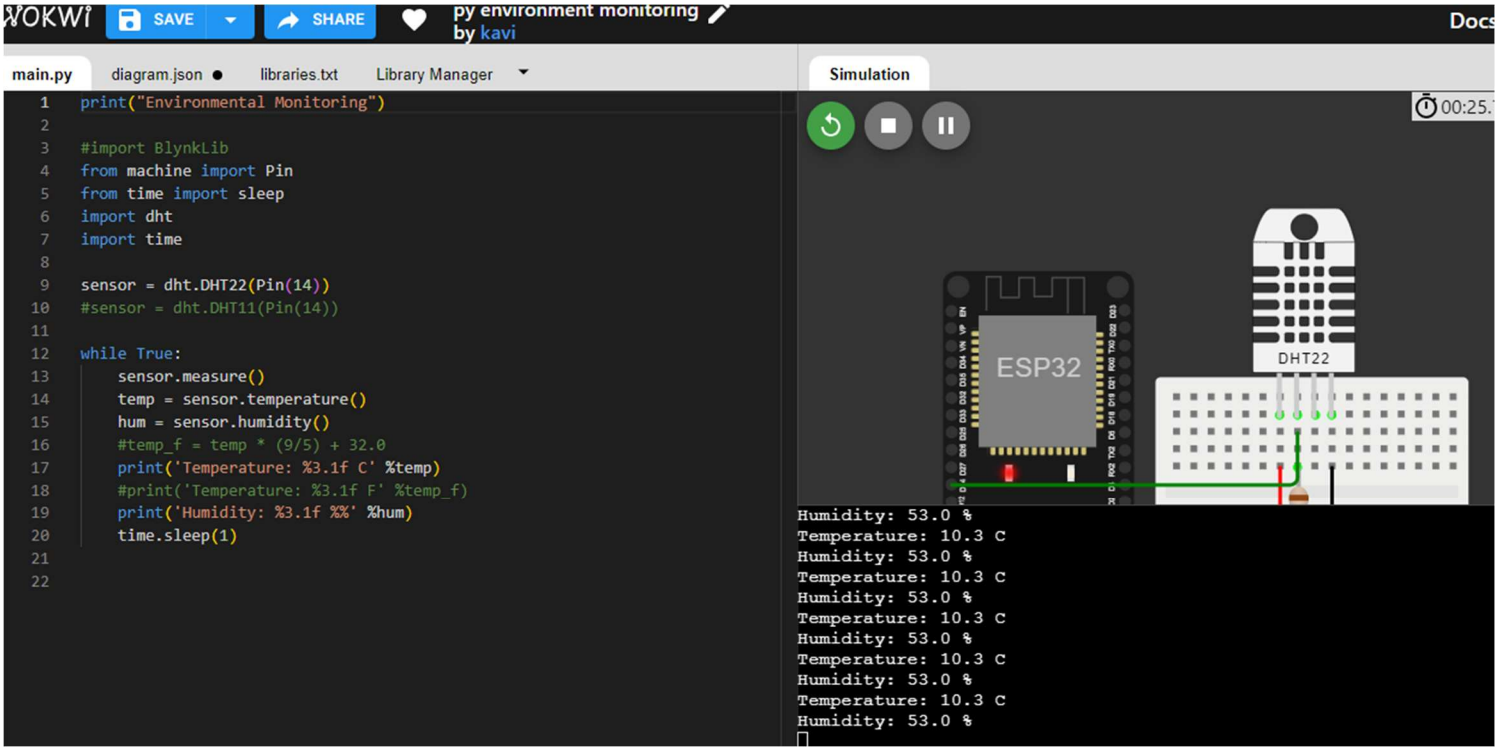
Simulation

00:10.032 65%




```
Wifi not connected
Wifi connected !
Local IP: 33557002
Temp: 38.70°C
Humidity: 65.5%
Data pushed successfull
---
```

Example2:


SAVE
SHARE
py environment monitoring
by kavi
Docs
main.py
diagram.json
libraries.txt
Library Manager
Simulation
00:25.
ESP32
DHT22
print("Environmental Monitoring")
#import BlynkLib
from machine import Pin
from time import sleep
import dht
import time
sensor = dht.DHT22(Pin(14))
#sensor = dht.DHT11(Pin(14))
while True:
sensor.measure()
temp = sensor.temperature()
hum = sensor.humidity()
#temp_f = temp * (9/5) + 32.0
print('Temperature: %3.1f C' %temp)
#print('Temperature: %3.1f F' %temp_f)
print('Humidity: %3.1f %%' %hum)
time.sleep(1)
Humidity: 53.0 %
Temperature: 10.3 C
Humidity: 53.0 %
Temperature: 10.3 C
Humidity: 53.0 %
Temperature: 10.3 C
Humidity: 53.0 %
Temperature: 10.3 C
Humidity: 53.0 %
Temperature: 10.3 C
Humidity: 53.0 %